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Engineering Bulletin

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THE MC145432 APPLICATION CIRCUIT

The purpose of this document is to provide a circuit capable of detecting 2600 Hz tone pulses on a telephone line as defined by the Bell System specification for type-F single-frequency signalling equipment.

The circuit in Figure 1 is designed to provide a 0 dB gain on the channel, and the overall circuit is set up for a 600 ohm system. The signals presented to the channel are driven through the band-pass filter and out pin 14 of U1 (the MC145432). The signals are also driven through the notch filter and output to pin 5. Both outputs are AC coupled to precision full-wave rectifiers and then averaged by integrators to produce a voltage level that is proportional to in-band energies of each filter.

A three-step decision process is used in determining if a valid 2600 Hz signal is present. The comparator U3A compares the two levels to determine which band has the most energy. If the band-passed signal has the most energy, the first step has been met. The second decision criteria requires the signal level to be at least −26.5 dBm ± 1.5 dB. This is measured by the comparator U3D by selecting R23 and R24 so that the voltage drop across R24 equals the peak voltage level presented at the input by a −26.5 dBm signal multiplied by the gain of the averaging circuit, which is 0.64. The circuit is presently set up for 600 ohms, so a −26.5 dBm signal is 0.0518 volts peak and the desired voltage drop must be 0.0518 × 0.64, which is 0.0332 volts. If gain is added at the channel input or the circuit is used in a 900 ohm system, R23 and R24 must be modified to provide the proper comparison level. The final requirement is the signal must be present for 38 milliseconds. This requirement is measured against the averager's speed and the two time constants, R17-C10 and R20-C11.

Bell requires that a notch filter be inserted into the channel if the 2600 Hz tone is present in excess of 13 milliseconds with a 6 millisecond margin. This requirement is met by the R17-C10 time constant. It takes about 7.5 milliseconds for C10 to charge past the 2.1 volt threshold presented by D6-D8. Since the averager takes between 0.5 and 11.5 milliseconds (dependent on input tone level) to provide levels usable to make the decision, the overall delay is within 5 milliseconds of 13 milliseconds, which is within specification. When the threshold is met, the comparator U3B goes high and drives U1 pin 12 high, which inserts the notch filter into the channel. Should the signal be lost at anytime during the charge cycle, C10 is discharged through R25, which represents a maximum discharge time of 0.5 milliseconds.

The output signal of U3B represents a delay of about 13 milliseconds and 38 milliseconds are required to meet the Bell standard, so the R20-C11 time-constant provides another 25 millisecond delay. The comparator U3C will go high if the 2600 Hz signal is present in excess of 38 milliseconds, thus the final decision criteria is met at this point.

There are several other factors that must be taken into account. The circuit must be able to respond to a signal in the +8.5 dBm to −26.6 dBm range ±1.5 dB variation in the presence of no more than 65 dBrnC noise. The circuit will detect a −25 dBm signal under these conditions, which is within the 1.5 dB spec. Another requirement is the ability to detect a tone that is as much as 15 Hz off frequency; however, this poses no real problem. There is one more factor known as talk-off. Although the Bell specifications does not directly address this problem, it can be difficult to deal with. Talk-off basically is caused by speech energy on an active phone line exceeding the tone energy and thus prematurely terminating the signal. There presently is enough protection to avert talk-off when voice signals reach 10 dB higher than the tone levels, but this can be augmented by varying R25. Increasing the discharge time means the excess energy in the notch band must remain for a longer period of time and this gives a better margin. However, if too long of a delay is introduced, another phonemena, know as talk-on, becomes a problem. This is when the circuit is energized by the voice energy caused by C10 not bleeding off fast enough. This is a qualitative trade-off left to the designer's judgement. Bell also specifies the detect signal's pulse length based on the length of the input burst but this is beyond the purpose of the circuit and can be easily implemented with some simple logic.

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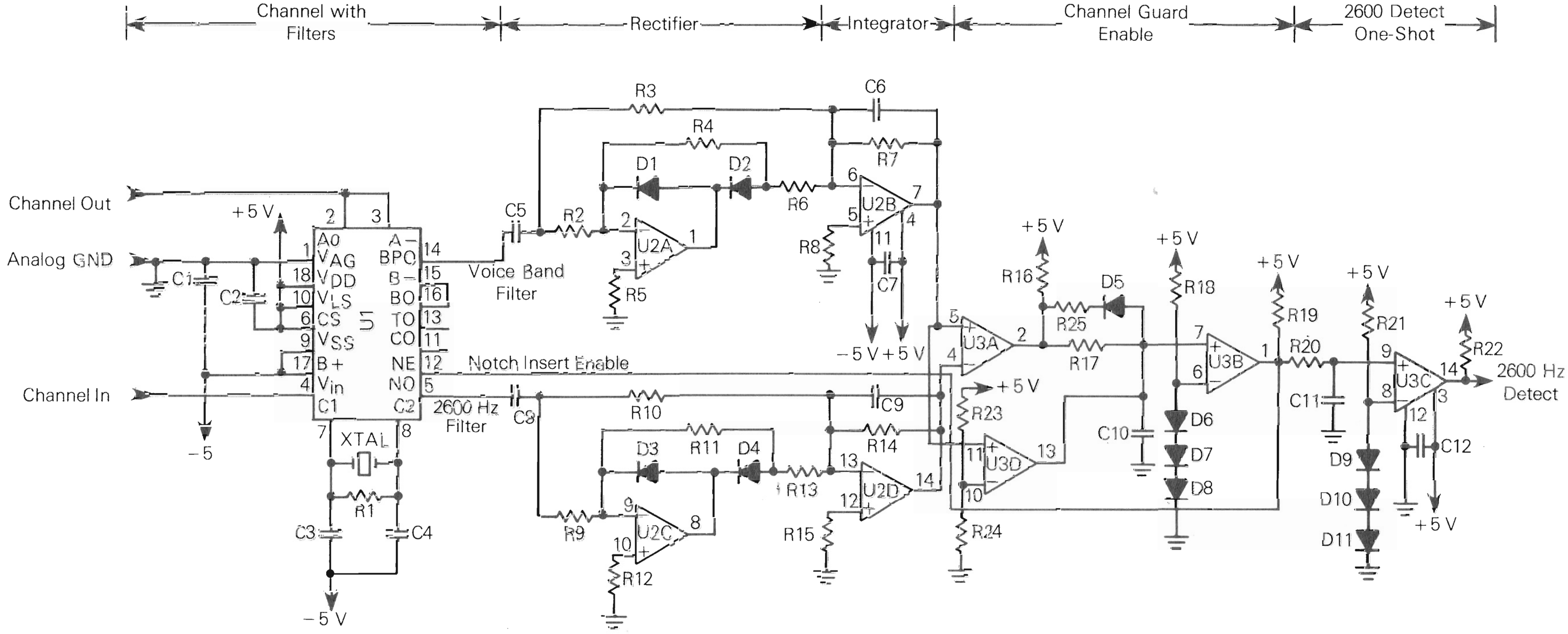

200 Ω	R24	39 kΩ	R17	1 μF	C11
1 kΩ	R4	47 kΩ	R20	4.7 μF	C5, C6, C8, C9
2 kΩ	R3, R7	62 kΩ	R25	IN914	D1-D11
5.1 kΩ	R8, R15, R16, R19, R22	10 MΩ	R1	U1	MC145432
10 kΩ	R5, R6, R12, R13, R18, R21	20 pF	C3, C4	U2	MC3403
20 kΩ	R2, R9, R10, R11, R14	0.01 μF	C1, C2, C7, C12	U3	LM339A
30 kΩ	R23	0.47 μF	C10	XTAL	3.579 MHz

FIGURE 1 — 2600 Hz Guard and Channel Circuit

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FIGURE 2 — MC145432 Block Diagram

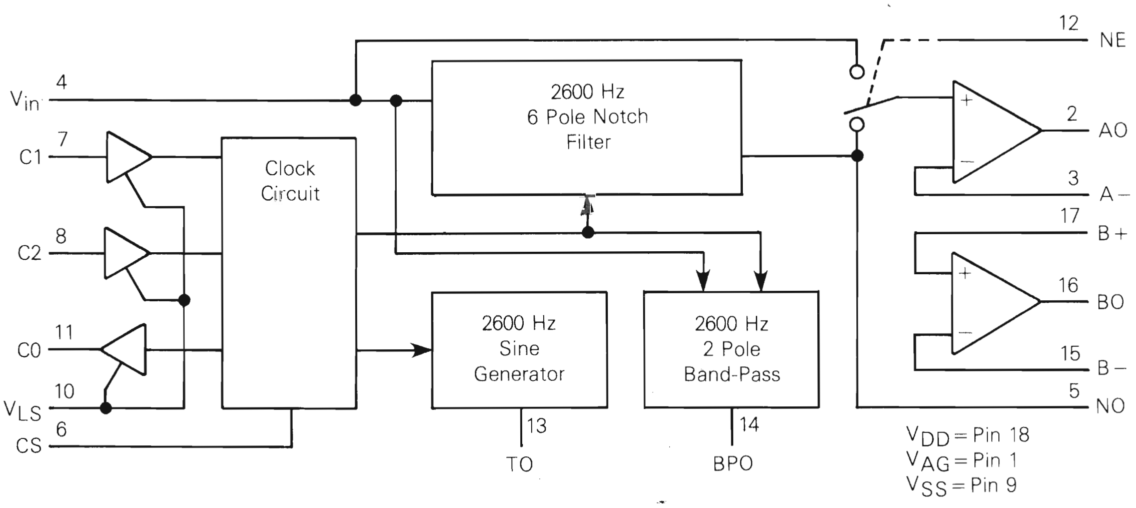


FIGURE 3 — Band-Pass Frequency Response

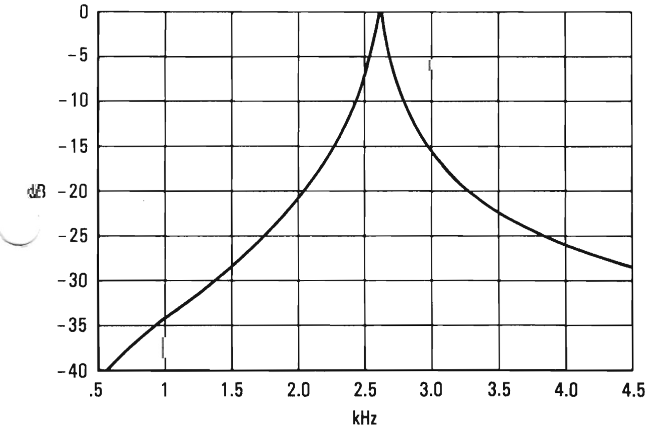
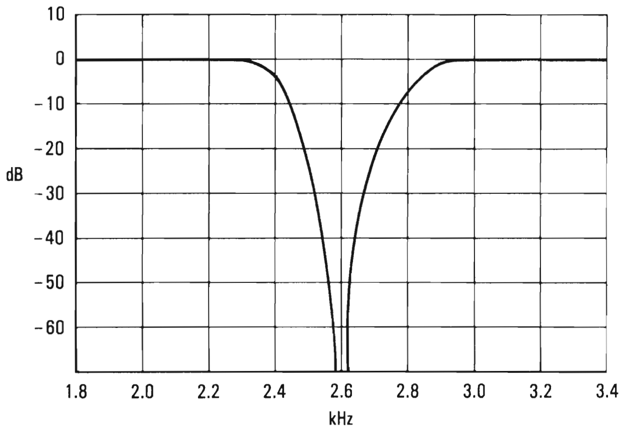


FIGURE 4 — Notch Frequency Response



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